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Urmia Lake Restoration Program

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Abstract

One of the most critical issues in Iran, which both people and authorities are faced, is drought of many watersheds and groundwater level reduction. In this paper, the drought procedure of the biggest picturesque lake in Iran, Urmia Lake, is explained. Based on academic researches three main reasons for Urmia Lake's crisis are improper development of the agricultural sector, improper water consumption pattern in potable, health and industrial sectors and last but not least climate change and continuing drought. Indeed, the renewable water use stands at 70%, which is significantly higher than the sustainable limit of the basin. Therefore, worsening condition of Urmia Lake from one side and the government's commitment to solve such national environmental crisis on the other side resulted in approving establishment of a program titled "Urmia Lake Restoration Program" which we are aiming to express and analyze in this paper. Ultimately, the essential strategies to save and restore Urmia Lake, all of which concentrate on significant decline in water consumption throughout the basin, are explained and measures taken till now are presented.

Keywords: Drought, Renewable Water Use, Sustainable Limit, Urmia Lake Restoration Program

1. INTRODUCTION

In the North-West of Iran, the basin of Urmia Lake, the country's largest in-land lake, covers an area of over 50,000 m^2; it is also a significant water ecosystem. Due to its unique natural and ecological characteristics, Lake Urmia is a protected area as a UNESCO Biosphere Reserve and a Ramsar Site. With all runoff flowing into the closed basin, perfect conditions are in place to assess and control various environmental elements. The average precipitation as well as the number of rainy days in the basin of Lake Urmia has significantly fallen (i.e. 18% which is equal to 68 mm) in recent years compared to that of previous time periods on record. Consequently, this trend has resulted in a drop in runoff and surface water inflow throughout the basin. Therefore the average runoff inflow to Lake Urmia has decreased by 50% (i.e. 2,500 MCM). The significant decline in the water level of the lake (Fig. 1 and 2) alongside renewable water resources (i.e. 21% which is equal to 1,850 MCM) reflects these terrible events. Presently, the renewable water use stands at 70%, which is significantly higher than the sustainable limit of the basin. Latest figures (June 2014) show a 50% drop in ecological water level and an 82% decline in Lake Urmia's water content [1].

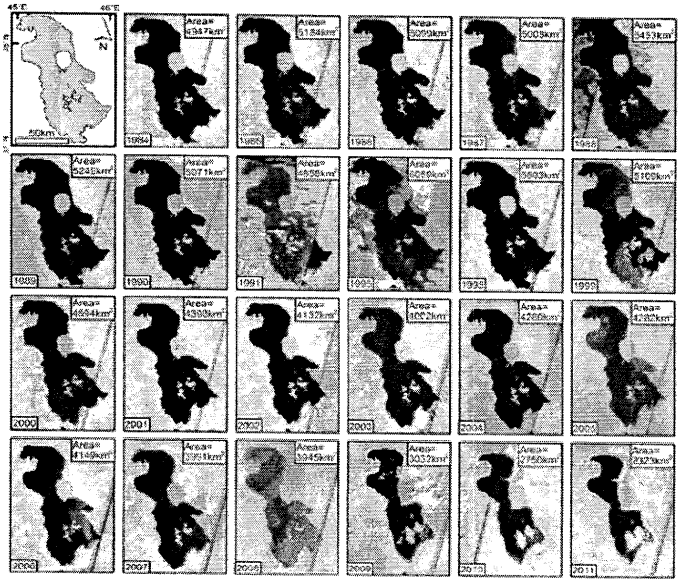

Figure 1: Lake Urmia, Changes in Water Level (1984-2011).

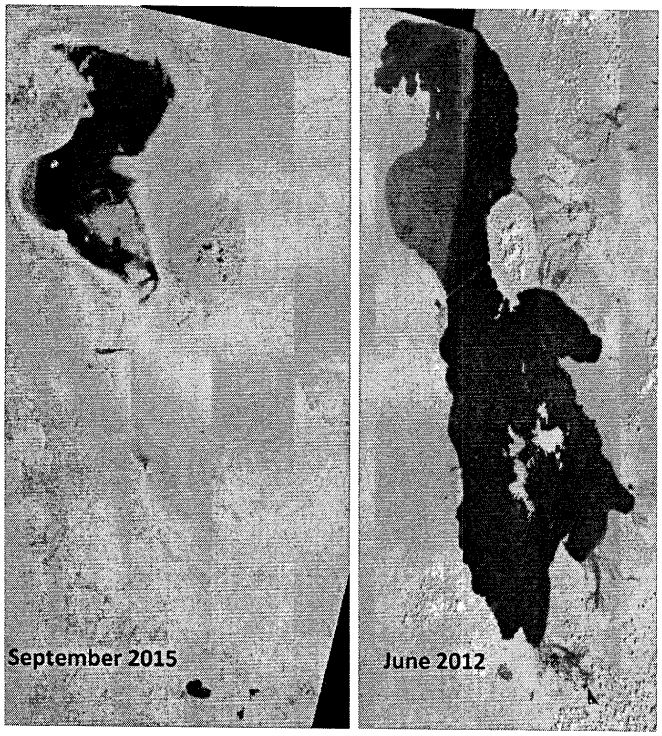

Figure 2: Lake Urmia, Water Level Status in June 2012 Compared to September 2015.

Present status of Urmia Lake is the result of unsustainable development in the catchment area for several decades and abnormal water withdrawal from the basin's renewable water. A complex of various natural and human factors such as executing various projects on water resources development, increasing development of the agricultural sector, changing the agricultural pattern

and producing high water-consuming products on the basin area, low water productivity and lack of effective protection from the basin ecological and environmental resources, as well as, climate change and decreasing rate of precipitation and surface runoff all over the Urmia water basin have brought about such conditions for the largest inland lake in Iran. In other words, lack of enough water flow into the lake in the recent years has resulted in an intensive trend of decreasing water level and lowering of its water volume.

2. An Analysis of Water Resources and Consumptioin Status in the Lake Urmia Basin

Currently, the water consumption in various sectors stands at 70% of the basin's renewable water resources, which is significantly higher than the amount of the stability limit of Lake Urmia. The agricultural sector is the largest consumer with a share of 89% of total renewable resources. Approximately 70% of renewable water resources are consumed in different sectors, with the agricultural sector using a minimum 60% of total renewable resources and 90% of total water use in the basin. While the admissible level of water withdrawal from renewable water resources stands between 20 to 40%.

In order to save and restore Lake Urmia, studies necessitate significant decline in water consumption throughout the basin, provision of environmental requirements of the lake as well as water transfer to Lake Urmia [2].

Iran's Ministry of Jihad-e-Agriculture along with Ministry of Energy are the government entities responsible for enforcement of the 40% water consumption decrease in the agricultural sector as a sustainable solution to address Lake Urmia crisis. The implementation of such measures leads to a 45% saving in renewable water resources. Releasing water storage of dams can remedy or to some extent address the critical status of the lake in the short-term. Implementation of various solutions to reduce consumption and transfer of water from Silveh and Zab basins and unconventional use requires a minimum of ten years for the restoration process of Lake Urmia to reach the ecological level [2].

3. Urmia Lake Restoration Program (ULRP)

Worsening condition of Urmia Lake from one side and the government's commitment to solve such national environmental crisis on the other side resulted in approving establishment of a program titled "Urmia Lake Restoration Program." Following up such program establishment, Ministry of Energy undertook to hold various professional and technical sessions and workshops, as well as professional meetings on "executive strategies to save Urmia Lake" in Tehran University which resulted in the approval of 19 prioritized projects to solve the problem of Urmia Lake. The 19 projects were approved in the program of saving Urmia Lake in the meeting dated 8 October 2013, which was eventually discussed and approved in the cabinet on 9 October 2013 for which the Minister of Energy takes the responsibility to coordinate and lead the execution of the Urmia Lake Restoration Program [3].

Considering the critical environmental conditions relevant to drought of Urmia Lake and considerable decrease of water level and volume, as well as enhancing and focusing on the actions related to Urmia Lake restoration, the cabinet held a meeting on 22nd January 2014 to establish "National Committee of Urmia Lake Restoration Program" based on 138 principal of the constitutional law on which Dr. E. Kalantari, was elected and approved as the staff secretary and executor of the project. Following such approval, the program has formally started and approached the activities as follows:

- Better analysis of Urmia Lake crisis dimensions such as effective factors originating such crisis, as well as present and future conditions of the lake;

- Attracting participation and cooperation of all responsible and relevant organizations and authorities to benefit from their professional and expertise points of view;
- Benefiting from know-how and participatory contributions of university professors, professionals, experts and researchers internally and externally;
- Emphasizing on the participation of local authorities in numerous and concordant activities to fulfill the Urmia Lake Restoration Program objectives;
- Attempting to create the public and comprehensive determination and participation through informative mass media to restore Urmia Lake, to improve its present condition and to observe it as "a public challenge";
- Compiling the road-map of Urmia lake restoration.

Urmia Lake Restoration Program established 6 professional committees, 20 various professional work-teams, carried out comparative studies (e.g. studied strategies already made on similar challenges in the world) and established regional councils to start its activities through professional, scientific and participatory approach to prepare a road-map and to execute a comprehensive strategy harmonized with Urmia lake restoration.

In 7 June 2014, Lake Urmia's water level was about 1,270.6 m, which illustrated a balance decrease of 3.5 m compared with the lake ecologic balance. Considering the negative trend in the lake level and the urgent requirement of supplying water not only to stabilize the present situation, but also to increase the level and volume of the lake water, some urgent actions are necessary. Urmia Lake Restoration Program reached to the turning point that the strategy of increasing water inflow to the lake through decreasing water uses in the basin agricultural sector, as well as, minimizing the water losses through the water conveyance to the lake water body would be the pivotal activities to restore Urmia Lake. Therefore, approaching such trend plus the required coordination with the Ministry of Energy and the Ministry of Jihad-Agriculture, the staff has defined the required projects and presented them to be executed. It is noteworthy that international experiences, especially those related to Aral Sea restoration, reveal that using the internal basin water resources, as well as, doing the essential steps for increasing water productivity all over the basin, would be beneficial to achieve the revival of Urmia Lake. The suggested water resources that can supply water for restoring Urmia Lake are mentioned in Table 1. Moreover, in Table 1, more details about annual volume of water transfer to lake water body can be found.

TABLE 1: WATER SUPPLY POTENTIAL FOR LAKE URMIA [4]

Water Source	Description		Annual Volume of Water Transfer to Lake Urmia's Water Body (MCM)
Current Volume of Water Transfer to the Lake from Rivers	*Net Water Inflow Volume to the Lake's Water Body*		*1,500*
Water Resources Outside Basin	*Water Transfer Project from Zab River*		*600*
	Water Transfer Project from Silveh River		*190*
Unconventional Water Resources	*Basin wastewater*		*300*
Reducing the Water Consumption in Agricultural Sector	*Savings in Agricultural Water Use (40%)*	*From Surface Water Resources*	*970*
		From Ground Water Resources	*370*
	Releasing Water Storage of Dams		*First Year: 510* *Second Year: 580* *Third Year: 640*
Reducing the Water Loss in the Lake's Buffer Zone	*Water Transfer to Lake's Body of Water*		*250*

The other important point is that the lake restoration is a time-taking approach. Executing the required strategies to revive and restore the lake to its natural ecologic balance will take at least 10 years. The predicted schedule to restore Urmia Lake till 2024 is illustrated in Table 2.

TABLE 2: URMIA LAKE RESTORATION TIME SCHEDULE UP TO 2023 [4]

	Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	Status	Stabilizing Period			Urmia Lake Restoration Period				Final Restoration		
Water Supply (BCM)	*Natural inflow of the rivers*	*1,500*	*1,500*	*1,500*	*1,500*	*1,500*	*1,550*	*1,600*	*1,650*	*1,700*	*1,800*
	Water conveyance from Zab						*600*	*600*	*600*	*600*	*600*
	Water conveyance from Silveh			*190*	*190*	*190*	*190*	*190*	*90*	*90*	*90*
	Water conveyance of Sewage					*100*	*200*	*250*	*300*	*300*	*300*
	Water conveyance to the lake water-body (decrease of losses)	*150*	*200*	*250*	*250*	*250*	*250*	*250*	*250*	*250*	*250*
	40% water saving in the agricultural sector (8% per year)		*227*	*450*	*800*	*1,070*	*1,340*	*1,340*	*1,340*	*1,340*	*1,340*
	Water release from the dams	*150*	*200*	*250*							
	Total	*1,800*	*2,127*	*2,640*	*2,740*	*3,110*	*4,130*	*4,230*	*4,230*	*4,280*	*4,380*
	Evaporation (million m³)	*1,486*	*1,728*	*1,959*	*2,052*	*2,068*	*2,276*	*2,512*	*1,647*	*2,718*	*2,923*
	Final restored volume (million m³)	*2,453*	*4,090*	*4,985*	*4,974*	*6,042*	*7,976*	*9,747*	*11,351*	*12,869*	*14,403*
	Final restored level (km²)	*2,072*	*2,435*	*2,792*	*2,990*	*3,215*	*3,600*	*3,845*	*4,044*	*4,166*	*4,331*

According to the program studies, the time-schedule for restoring the lake up to the year 2022 is illustrated in Table 3. It is noteworthy to make the required actions to supply more water for Urmia Lake to fulfill the planned objective. For decreasing the period of two years from the planned time-schedule of Urmia lake restoration up to the year 2024, actions to be carried out are as follows:

- More volume of water conveyance to the water body and further decrease of water losses;
- Increasing the volume of water conveyance from Silveh River to Urmia Lake;
- Decreasing the agricultural water consumption trend from 10% to 8% per year;
- Continues water releasing from the dams up to the year of 2019.

TABLE 3: URMIA LAKE SCHEDULE (UP TO THE YEAR 2022) [4]

	Year	2014	2015	2016	2017	2018	2019	2020	2021
	Status	Stabilizing Period			Urmia Lake Restoration Period		Final Restoration		
Water Supply (BCM)	*Natural inflow of the rivers*	*1,500*	*1,500*	*1,500*	*1,500*	*1,500*	*1,550*	*1,600*	*1,700*
	Water conveyance from Zab						*600*	*600*	*600*
	Water conveyance from Silveh					*350*	*350*	*350*	*350*
	Water conveyance of Sewage					*100*	*100*	*100*	*100*
	Water conveyance to the lake water-body (decrease of losses)	*150*	*250*	*300*	*350*	*350*	*400*	*400*	*400*
	40% water saving in the agricultural sector (8% per year)		*280*	*540*	*800*	*1,060*	*1,340*	*1,340*	*1,340*
	Water release from the dams	*510*	*580*	*640*	*700*	*700*			
	Total	*2,160*	*2,610*	*2,980*	*3,350*	*4,060*	*4,440*	*4,540*	*4,690*
	Evaporation (million m^3)	*1,527*	*1,727*	*1,928*	*2,092*	*2,292*	*2,492*	*2,687*	*2,805*
	Final restored volume (million m^3)	*3,378*	*4,261*	*5,313*	*6,571*	*8,339*	*10,287*	*12,139*	*14,024*
	Final restored level (km^2)	*2,529*	*2,823*	*6,063*	*3,356*	*3,648*	*3,935*	*3,935*	*4,285*

On the whole, the program has defined its mission as "Urmia Lake Restoration" and its outlook in 2014 based on the performed professional and expertise studies, has chosen to reach to its ecologic balance. Following its mission, the program has established an operative plan to fulfill the outlook of Urmia lake restoration with 26 required strategies of which 18 are executive and 9 are study strategies. Fourteen strategies were approved in the meeting held by National Committee of saving Urmia lake on 29 April 2014, which was issued to the working group members in the latter ref. 18171 dated 18 May 2014 by the honorable first deputy of president; the other 12 strategies were discussed in the meeting held by the working group and approved on 29 June 2014. It was also suggested that proper strategies be studied by the staff and the relevant entities. Such strategies are as follows [3]:

1. The approved strategies in the meeting held on 29 April 2014 by the national committee of Saving Urmia Lake are as follows:
   A. Executive Strategies:
      i. Prohibition of any kind of additional withdrawal from the basin water resources and prevention of new development especially in the agricultural sector;
      ii. Preventing unpermitted withdrawal from the surface waters;
      iii. Stopping all the dam construction projects under study and under operation (except for shahid Madani and Cheragh-veis Dams), as well as downstream irrigation and Drainage projects in Urmia lake water basin and water reservoir and release in Shahid Madani Dam, exclusively for Urmia Lake);
      iv. Securing the required budget and enhancing water conveyance project from the Zab river to flow into the Urmia Lake Water Basin;
      v. Establishing and executing the comprehensive education plan, informing and awakening procedures, as well as, absorbing public and local communities participation to highlight the results of the present situation and the importance of Urmia Lake Restoration;

vi. Setting the affairs relevant to the Urmia lake water basin and installing smart and volumetric meter to control water withdrawal in line with increasing river water inflow into the Urmia Lake;
vii. Monitoring to decrease the agricultural sector water consumption:
- Decreasing 40% ground and surface water rights, being purchased by the Ministry of Energy in two years;
- Decreasing and performing the productivity increase plan on the 60% remained water in the agricultural sector by the Ministry of Jihad-Agriculture;
- Supplying the required capital and technologies to increase the productivity of the remained water by the government;

viii. Conveying water to the islands and wetlands in the basin of Urmia Lake from Hasaan-lue Dam and re-opening the water inflow courses to the southern wetlands;
ix. Preparing the Urmia Lake water basin cadaster areas;
x. Executing the approved projects by the executive entities together with monitoring and supervising the project's execution by the Urmia Lake Restoration Program.

B. Feasibility study strategies:
i. Designing and settling the comprehensive management of decision support system of Urmia Lake water basin;
ii. Studying and analyzing the Shahid Kalantari access road on Urmia lake and presenting reforming strategies;
iii. Assessing and feasibility study on industrial productivity of Urmia lake minerals by considering environmental issues.

2. Approved strategies in the meeting dated 29 June 2014 by Urmia Lake Restoration Program:
A. Strategies to be done:
i. Water conveyance of the river to the lake water body;
ii. Exploring dust production centers for stabilization;
iii. Studying and executing ecologic protection project of Urmia Lake national park prioritizing its southern region;
iv. Performing the required coordination with the judiciary power to facilitate and enhance the execution of the law on the water-wells lacking permission, especially the ones effective on surface water;
v. Reconnaissance of the area limits effective on the main aquifers conveying water to the Urmia lake;
vi. Enhancing the execution of water conveyance from Silveh river at the vicinity of west Azerbaijan exclusively from Urmia Lake according to the allocation approval of the Ministry of Energy;
vii. Establishing Research Centre for the future of Urmia Lake by the Environment Protection Organization.

B. Study strategies:
i. Pathology of health, hygienic, social and environmental effects resulted from partial drying of Urmia lake, preparing the executing preventive project to decrease potential risky effects;
ii. Preparing a program for increasing employment and sustainability way of living by the relevant entities;
iii. Feasibility study of using modern technology appropriate with Urmia lake restoration;
iv. Studying the project of water conveyance from the Caspian sea to Urmia lake;
v. Reconnaissance of halo culture, sustainable use of saline soil and water resources suitable for the flora of the region around Urmia Lake.

3. Strategies proposed but not approved yet:

A. Stopping cultivation in shallow areas of Nowruz-Lu diversion dam and Zarrina-rud junction to Simineh-rud areas for 3 years and paying compensatory remunerations to the farmers
B. The Urmia Lake Restoration Program has already established relevant program along with the required coordination and meeting with the managers, and experts of the responsible authorities. This comprehensive program included the required projects, the executing entity of each project, the needed budget (the title of the existing budget, and assessment of the future required budget).

4. MEASURES TAKEN

Although it is the country's first real experience in terms of integrated management with the participation of 17 organizations, the results are significantly valuable and productive. The main actions that have had a profound impact on increasing the volume of water entering the lake are listed below:

- Stop all developed or under-developed dam projects, irrigation and drainage network construction, which could conserve 1,275 million cubic meter of lake's water right;
- Releasing 576 million cubic meter water from dams during two last years;
- Dredging rivers poured into the lake;
- Transferring 131 million cubic meter wastewater from the existed treatment plants;
- New sewage network construction (around 55% has been progressed);
- Controlling and decreasing water withdrawal from surface and groundwater resources has produced 90.3 million cubic meter water saving;
- Exploring dust production centers and stabilizing them (around 12,000 hectares);
- Improvement water productivity in irrigation network and agricultural section lead to 78 million cubic meter water saving.

Although these helpful actions have been already been taken, the present condition of Urmia Lake is not matched with the anticipations in the road map. Indeed, the recent lake level is 28 cm lower than predicted at this time, which revealed the obstacles in implementation.

5. CONCLUSION

Various studies have shown that the current crisis in Urmia Lake is due to improper development of the agricultural sector, climate change and continuing drought. The average rainfall in the region has decreased 18% (i.e. 68 mm) in recent years. Also, the amount of renewable water resources in the basin has declined 21% which is equal to 1,850 million cubic meters reduction. At present the use of renewable water resources in the basin is 70%, far higher than the regional stability level and needs to be reduced to 40% range. By applying a 40% reduction in agricultural water use, the use of renewable water resources would be decreased up to 45%, ultimately stability return to the basin and the lake will be restored as a long-term effect. Since water transfer projects are time-consuming while the current status of the lake is crucial, the advised urgent measure which should be taken in short-term to make the lake stable and recover it to the ecological condition are: reducing water losses in the Buffer zone, reduce water consumption in the agricultural sector and releases water from dams. Finally, by applying different restoration strategies such as reducing water consumption, transferring water from Silveh and Zab basin and unconventional water resources within the basin, the revitalization process will require a 10-year period time at least.

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